

CLUSTER RESEARCH REPORT
No. 2.2

Investigating constructive technology assessment within the Minerals Down Under Flagship: Interview results

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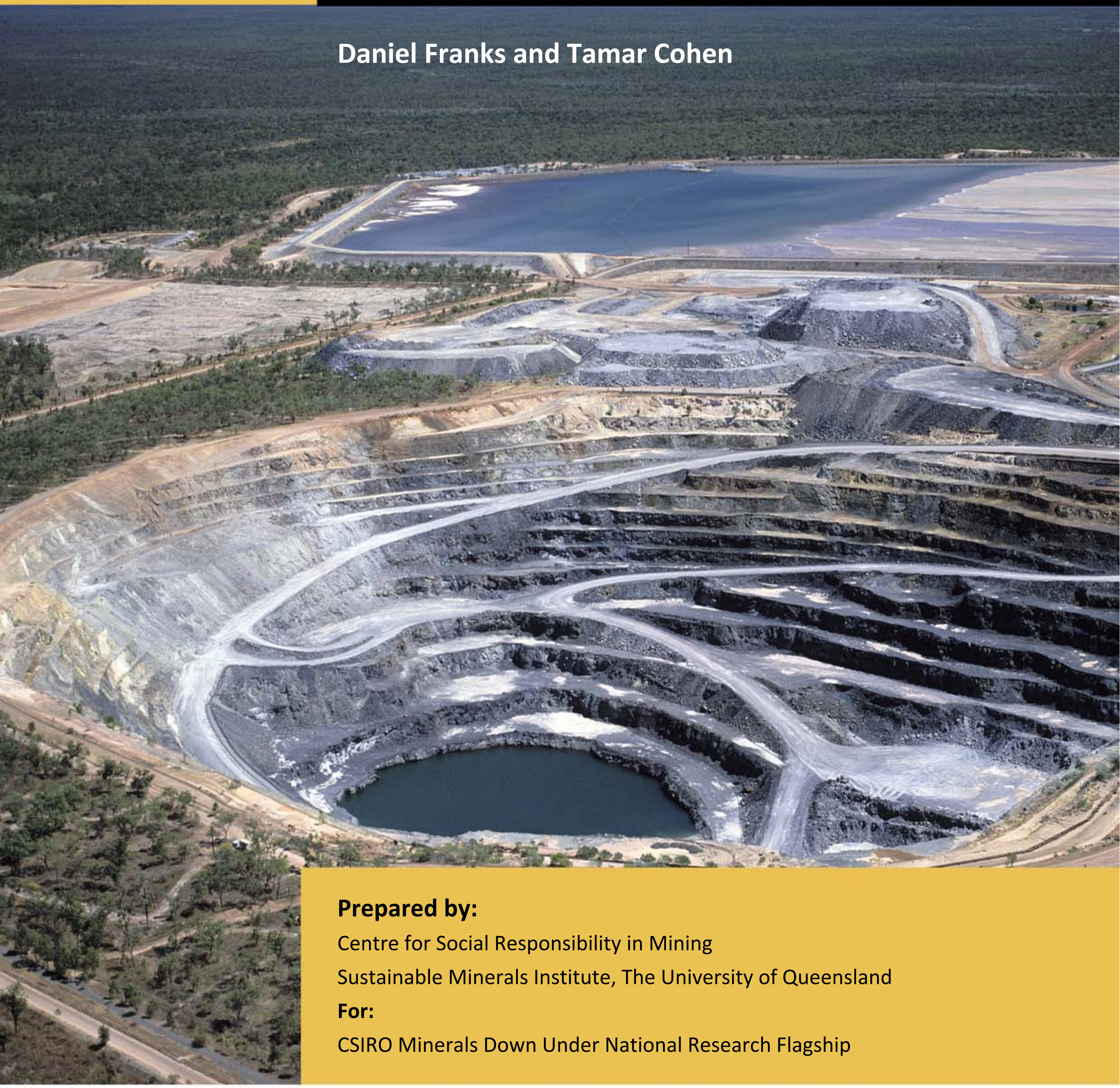

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For:

CSIRO Minerals Down Under National Research Flagship

National Research FLAGSHIPS Minerals Down Under
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Centre for Social Responsibility in Mining

The Centre for Social Responsibility in Mining (CSRM) is a centre within the Sustainable Minerals Institute, University of Queensland, Australia. CSRM works with companies, communities and governments to respond to the socio-economic and political challenges brought about by resource extraction. The Centre's aim is to help build the capacity of these stakeholders to manage change in more effective ways. CSRM has global reach, with particular experience in Australia and the Asia-Pacific. For more information visit our website at: http://www.csrm.uq.edu.au.

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CITATION

Cite this report as:

Franks, D.M, and Cohen, T. 2011. Investigating constructive technology assessment within the Minerals Down Under Flagship: Interview results. Prepared for CSIRO Minerals Down Under Flagship, Minerals Futures Cluster Collaboration, by the Centre for Social Responsibility in Mining, Sustainable Minerals Institute, The University of Queensland. Brisbane.

ACKNOWLEDGEMENT

This research was undertaken as part of the Minerals Futures Research Cluster, a collaborative program between the Australian CSIRO (Commonwealth Scientific Industrial Research Organisation); The University of Queensland; The University of Technology, Sydney; Curtin University of Technology; Central Queensland University; and The Australian National University. The authors gratefully acknowledge the contribution of each partner and the CSIRO Flagship Collaboration Fund. The Minerals Futures Cluster is a part of the Minerals Down Under National Research Flagship. Special thanks are extended Anna Littleboy, Kieren Moffat, David Brereton, Rodger Barnes, Tim Horberry and Danellie Lynas for their assistance in the preparation of this work. A version of this paper was published as 'Social License in Design: Constructive Technology Assessment within a minerals research & development institution' in the proceedings of the Fifth International Conference on Sustainable Development in the Mineral Industry, 2011, Aachen, Germany.

CONTENTS

ABSTRACT

Technological innovation in the minerals industry must be driven by the need to improve performance according to social, as well as environmental, safety, efficiency and production criteria. This paper outlines the possibilities and rationale for incorporating constructive technology assessment into technology research and development within the CSIRO Minerals Down Under National Research Flagship (MDU). The paper develops a process of Social License in Design that attempts to address the future social challenges and opportunities of a technology during development by utilising forecasting techniques and accounting for the perspectives and values of decision makers and likely stakeholders. Interviews with senior technologists and social scientists within MDU reveal the institutional context into which the Social License in Design process is to be situated and highlight key factors that may inhibit or enhance its uptake.

1. INTRODUCTION

Social performance is receiving greater emphasis and prioritisation within the extractive resource industries. Through approaches such as social impact assessment, ISO 26000, community development programs and trusts, community engagement and consultation, and the employment of social and communication specialists within community relations teams, some companies within the sector are seeking to improve the conduct of their operations and better respond to the social context in which they operate (Kemp *et al.* 2006; Kemp, 2009, 2010; Franks *et al.* 2009; Franks, 2011).

Social performance, however, is also profoundly influenced by the design traits of the technologies employed to extract and process mineral resources and the interplay between these traits and their environmental and social context. At one extreme inappropriate technology can lead to considerable harm to the public, mine employees as well as the environment and lead to tangible and intangible costs to industry including reputational loss, costly retro-fitting, disruption to production and even the closure of an operation due to a loss of social license to operate. Technological change may also induce social and economic change such as shifts in employment and skills requirements, or economic returns to communities that may not necessarily lead to social conflict but nonetheless require careful attention.

The future environmental, social, economic and safety outcomes of an operation can to a certain extent be embedded within technologies because once engineered and then sunk into a landscape technology can be difficult and very costly to retrofit (Franks *et al.* 2010). The technological aspect of social performance shifts the domain of focus from mining companies who implement technology to also include the R&D institutions involved in technology development. There is evidence that R&D institutions are shaping their investments to address environmental sustainability and safety challenges (SMI, 2006; CSIRO, 2009). The fields of Safety in Design (also known as Safe Design, or Prevention through Design), Resilience Engineering, Sustainable Design and SUStainable OPerations (SUSOP) have articulated conceptual and practical methods to encourage the development of extraction and processing technologies that are responsive to environment and safety criteria (Hollnagel *et al.* 2006; McLellan *et al.* 2009; Corder *et al.* 2010; Horberry *et al.* 2010). Less focus to date has been placed on conceptual design processes that respond to social challenges (notable exceptions include Russell et al. (2010) and Geels and Schot (2007). Even fewer examples exist of efforts to practically embed such social design processes into minerals R&D institutions (Katz and Solomon, 2008).

In this paper we outline the potential of Constructive Technology Assessment (CTA) to improve the social performance of technologies under development within the CSIRO Minerals Down Under National Research Flagship (MDU). MDU is an initiative of the Australian government that aims to unlock Australia's future mineral wealth through transformational exploration, extraction and processing technologies. MDU is actively developing technology to locate and characterise ore bodies using predictive modelling and geophysics, automate production and transport processes, improve efficiency in extraction through leaching and solute transport processes, create value from processing waste streams, as well as increase the water and energy efficiency of processing operations.

This paper reports on the progress of a 3-year applied research project to develop technology assessment methods and tools and apply these within MDU. The research project is part of the Minerals Futures Collaboration Cluster, a partnership between CSIRO and four Australian

Universities to address the future sustainability challenges of the Australian minerals industry. Interviews with senior MDU staff explore the opportunities and constraints to the practical implementation of CTA within the flagship. The paper develops a CTA process called Social License in Design that is shaped with reference to the implementation issues identified in the interviews. Social License in Design seeks to address the future social challenges and opportunities of a technology under development by considering the potential performance of the technology in its future operational context and accounting for the perspectives and values of potential stakeholders and decision makers.

2. BACKGROUND

2.1. SOCIAL LICENSE TO OPERATE AND TECHNOLOGY

Whilst necessary, compliance with statutory regulations is often insufficient to meet societal expectations (Bridge, 2004). This realisation has lead to the development and now widespread use of the term social license to operate within the minerals industry. Social license to operate refers to the intangible and unwritten, tacit, contract with society, or a social group, which enables an extraction or processing operation to enter a community, start, and continue operations (Joyce and Thomson, 2000; Thomson and Boutilier, 2011). The term was first proposed in 1997 by Jim Cooney, then Director of International and Public Affairs, Placer Dome (Thomson and Boutilier, 2011). Social license to operate is not an agreement between communities and operations that can be formalised in any way but, rather, must be thought about as a descriptor of the state of the relationship between a proponent and the community in which the proponent is operating and, therefore, as a process of continual negotiation. Social license to operate is a complement to regulatory licenses but is not a product that can be granted by civil authorities, political structures or the legal system (Solomon *et al.* 2008).

Social license to operate is usually considered with reference to project stakeholders (those affected by, or that can effect, the technology, operation or event). When talking about stakeholder relationships it is necessary to state that those directly located in the vicinity of an operation (communities of place) as well as those with a legitimate but perhaps less immediate interest (communities of interest) are both critical informants that shape the nature of social license. The process by which social license is expressed is contextually specific, dynamic and non-linear. This means that stakeholder perceptions of activities that affect them depend on the community and operation at hand and can change through time. This makes it difficult to definitively determine whether a new technology will gain social license until the technology is actually implemented. It also means that social license to operate can be withdrawn at any stage in the operation by a stakeholder if they become concerned about the operation or disenfranchised from the process.

Nelson and Scoble (2006) identify conditions that industry personal consider critical to acquiring and maintaining social license. These include maintaining a positive corporate reputation, understanding the cultural and historical context of the community and operation, educating local stakeholders about the project and ensuring open communication among all stakeholders. The conduct of the company is, evidently, of critical importance especially in fostering trust in company-community relationships. However the nature of the activity and the technology employed by an operation in its particular political, geographical, geological, and social context is a fundamental issue not identified by Nelson and Scoble (2006).

Technologies and technological processes are irretrievably linked to both the operation and the operator's behaviour. Technological traits can have a profound effect on the establishment or maintenance of a social license. At one level, acceptance of a technology is based on perceptions of the risk of that technology; for example, social license can be influenced by whether the technology is considered to be harmful, benign, beneficial or essential. These categories are not mutually exclusive however. Perceiving a technology as essential does not necessarily mean that an individual would accept that technology in their local area. Examples include controversies over the construction of mobile telecommunication towers in residential areas and or near schools. The overlap exists because attitudes towards technologies are ultimately bound up in both individual's aspirations as human beings (Tiels and Oberdiek, 1994) and personal perceptions of risks associated with the technology. Technological components are but one factor, albeit a very important one.

Thomson and Boutlier (2011) have identified various levels of strength in social license 'contracts' meaning various levels of social approval and acceptance of the operation. At the lowest level of social license to operate the relationship between the community or a network of stakeholders and the operation is one of acceptance only. The community 'puts up' with the operation. A higher level of social license is reached when the stakeholder explicitly approves of and encourages the continuation of the activity. The highest level is achieved when a community perceives the operation to be integral to their communal identity and values and therefore feel a sense of co-ownership over the operation. An example is when residents willingly identify, are proud of, and encourage their town's identity as a mining town.

Stronger levels of social license are argued to be gained as an operation establishes legitimacy, credibility and a lasting and affective level of trust (Thomson and Boutilier, 2011). The strength of social license can also be reversed as trust, credibility and legitimacy are impacted or lost, leading eventually to a stakeholder's withdrawal of social license, or the withholding of social license to begin with, as shown in the left hand column of Figure 1. It is important to note that processes of strengthening and or weakening social license relationships are not linear and thus a state of 'co-ownership' can rapidly deteriorate to a state of 'withdrawal' if a problem of significant scope arises. This is why a social license must be thought about as a process of continual negotiation rather than as a legal contract with defined clauses and actions for involved parties.

The relationship between the state of social license and stakeholder behaviour are thus closely linked. If a project, activity or technology, is considered untrustworthy, lacking credibility and illegitimate then a stakeholder may actively, or passively, resist that project. Conversely, if such social capital exists a community may actively champion a project (see right hand side Figure 1). Further a stakeholder may comply or co-operate depending on whether they accept or approve of the activity. The strength and resilience of the relationship between an operation and its stakeholders will influence the response of stakeholders to events, and, as such, the ease with which social license may deteriorate or be withdrawn. This can be thought of as the resilience in the relationship. The more robust the relationship the more it takes for the social license to be withdrawn. It is important to note, however, that there is a diversity of sometimes conflicting perspectives that are held within a community, stakeholder group, and even within an individual that in practice blur the delineation of these categories.

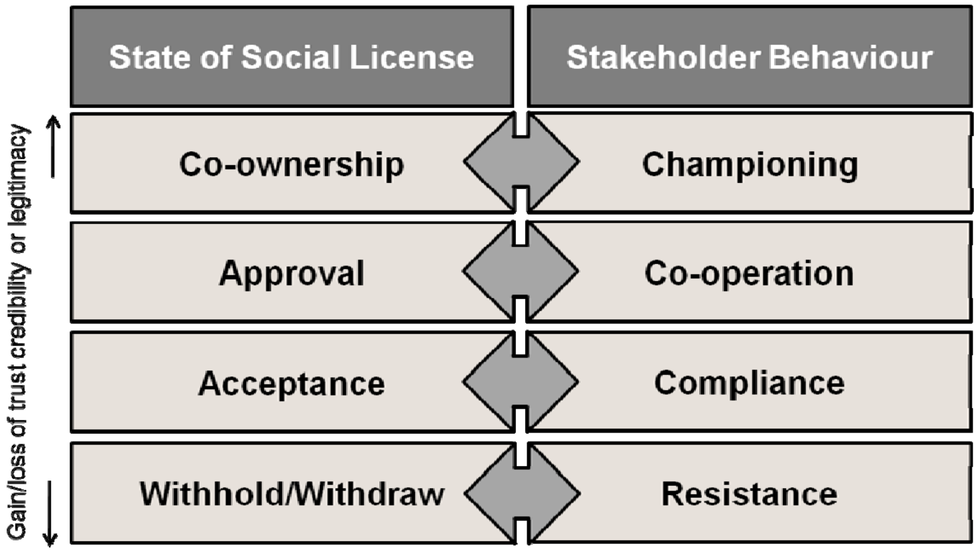

Figure 1: Relationship between the state of a social license and stakeholder behaviour (adapted after Thomson and Boutilier, 2011).

2.2. FORESIGHT THROUGH CONSTRUCTIVE TECHNOLOGY ASSESSMENT

Technology assessment has a long history as a method to inform research, development and decision-making. Due to the close relationship between social license to operate and technology there is an opportunity to address future social challenges within the design stage of technology development through forecasting processes such as Constructive Technology Assessment. CTA refers to a particular form of technology assessment that seeks to influence the design process of technology through dialogue and interaction with technology developers (Schot and Rip, 1997). Guston and Sarewitz (2002) define CTA to include three particular analytical components these being socio-technical mapping, early and controlled experimentation and identification of unanticipated impacts, and communication between technology proponents and the public. These components allow social aspects to become additional design criteria of technologies (Schot, 1992). In practical terms CTA can illicit information on the values, perspectives and background of potential stakeholders and anticipate likely stakeholder responses to the change that a new technology may bring.

CTA seeks to affect technological developments by incorporating values and ideas that may exist outside of the concerns of narrowly defined technological trajectories. Drawing on Beck's notion of reflexive modernisation (Beck *et al.* 1994; 2003) Voß and Kemp (2006) argue that to avoid unintended consequences and second-order problems the isolated perspectives in which problems are often addressed must be widened to include external filters of relevance. They argue that constructive TA is a way of creating interaction between various rationalities and taking into account the complexity of social, technological and ecological interrelationships (Voß and Kemp, 2006). In this way technology (and technologists) can become reflexive as social rationalities are reflected in technological outcomes and technologies (and technologists) reflect inwardly on, and hopefully transcend, the factors (structures) that shape technological pathways (see Rip, 2006 & Stirlng, 2006).

In the following section we report on interviews undertaken with senior MDU staff to develop and refine a CTA process as it might apply within a minerals R&D institution.

3. METHOD

Qualitative open-ended interviews were conducted to understand the institutional context into which the Social License in Design process is to be situated and to highlight key factors that may inhibit or enhance its uptake. Interviewees (n=10) were either current (n=9) or former CSIRO employees (n=1) and were selected based on their experience with minerals technology development or the social aspects of technological innovation. Interviews took 72 minutes on average and were conducted over the telephone or in person. In total over 12 hours of interview data was transcribed and, subsequently, analysed using NVIVO software. Analysis involved organising key quotes into representative nodes based around the following lines of enquiry:

- How open are technologists to the idea of technology assessment during the design phase? What factors influence this openness?
- How open are social scientists to the idea of technology assessment during the design phase? What factors influence this openness?
- What internal factors influence how the process can be situated within CSIRO MDU?
- What factors influence the reflexivity of technology development?

These nodes reflect current research into barriers to effective interdisciplinary work (Chubin et al, 1979; Fox et al, 2006; Franks et al., 2007), the institutional barriers to conducting interdisciplinary TA within scientific research institutions (Katz and Solomon, 2008; Katz *et al.* 2009) and ideas about producing techno-scientific expertise that reflects societal concerns especially the ability of technologies to be altered accordingly (Genus, 2006; Russell *et al.* 2010).

Interview data has not been quantified and instead remains descriptive. This suits an interpretative method of analysis that is appropriate for assessing the organisational factors that may either prevent or enhance uptake of the Social License in Design process within MDU.

For ease of analysis interviewees have been classified as either physical or social scientists. These groups mask the reality of disciplinary diversity within both groups. Physical scientists included chemical and metallurgical engineers, geologists and geochemists whilst the social scientist group includes behavioural psychologists, human geographers as well as staff who were originally trained in engineering or another discipline and who had ‘crossed-over’ to the social sciences.

4. RESULTS

4.1. HOW OPEN ARE TECHNOLOGISTS TO THE IDEA OF TECHNOLOGY ASSESSMENT DURING THE DESIGN PHASE? WHAT FACTORS INFLUENCE THIS OPENNESS?

All of the interviewees with a technical background expressed ‘in principle’ support for a technology assessment process becoming a component of CSIRO technology development. In general there was recognition that technology assessment could reduce business risk; an explicit consideration in the risk assessment process of CSIRO project development.

> *There is very, very definitely an important place for [technology assessment] to be played…we try not to develop technologies that are going to increase risk (SLD03).*

Technologists saw the process as a way to educate the public about risks associated with technologies. This was the primary value attributed to the process.

> *and it's a matter, not in a nasty respect, proving them wrong, but showing them [the public] what the truth is (SLD03).*

> *you can have a real perception problem about what is a real risk and what is a significant risk (SLD03).*

One interviewee thought that the value of TA went beyond TA as a risk communication tool commenting on the potential economic benefit of designing conflict out of technologies.

> *If you tackle a problem early enough, it doesn't necessarily cost you a lot to fix it up. If you wait until you've done 90% of your construction, then it may cost you a lot of money to get back and change something that is relatively minor to change in the first place (SLD02).*

There was an explicit recognition that the process would not suit all technologies and that it would only be internally supported if people perceived real benefits from the process.

> *they've got to sort of see that (sic) what's the size of the benefit ... and if your solution's going to be overall beneficial or if it's just going to help one bit, but then add another cost somewhere else (SLD09).*

When questioned about who should be involved in technology assessment process some technologists were wary of engaging the public, seeing such engagement as a potential project risk.

> *And that by shining a spotlight on it you'd be drawing attention to some of the controversial aspects of particular technologies, and that was a risk. And the best way to manage that risk is to just not shine the light (SLD05).*

In the past this perception had led people to avoid developing certain technologies that were likely to have a degree of public controversy attached to them.

> *...in my experience ... people tend to walk away from developing the technology in the first place if they feel there's a really challenging social risk associated with it (SLD10).*

> *I guess to some extent we leave that a bit more to the companies involved. Because it tends to be a human relations matter, and it's something they have got to deal with (SLD03).*

Support levels varied based on an interviewee's previous work experience, especially their location in the research and design process (how removed they are from the implementation side of technologies) and whether they had worked closely with community members on research projects. The latter factor has been commented on by Katz *et al.* (2009) stating that CSIRO as an organisation has been more inclusive of public interest in technology development in fields such as natural resource management, where the public is a dominant stakeholder, rather than in more technological areas of research in which the link to the public is one or two steps removed.

> *It's [social risk] not even on the radar ... because you're so far removed from deployment of a technology when your designing them in the transformational space, that that's stuff for other people to worry about (SLD01).*

Close involvement or previous work experience in the mining industry was also a factor that enhanced people's support of a technology assessment process.

> *We have a lot of people that have grown up in the organisation that haven't worked in industry and therefore haven't experienced the problems and often haven't had the social interaction with people impacted by the industry as well (SLD02).*

4.2. HOW OPEN ARE SOCIAL SCIENTISTS TO THE IDEA OF TECHNOLOGY ASSESSMENT DURING THE DESIGN PHASE? WHAT FACTORS INFLUENCE THIS OPENNESS?

CSIRO personnel working in social science positions expressed considerably more concern about how a process of technology assessment would work than those employed in a technical capacity. Whilst social scientists were supportive of the concept they were wary of how it would manifest within the institutional context of CSIRO. Interviewees were especially cautious of the potential for social science in CSIRO to become a service discipline to technologists. In general there was a recognition that mutual benefit could realistically only come about if the social scientists were involved from the outset and worked together with technical scientists to understand the domain issues and to develop project components and deliverables.

> *But part of what our group doesn't want to become is just a plug in service centre. So we'd rather be designing projects than being called upon to just to be sort of an extended admin, I guess (SLD07).*

Social science staff were skeptical of the degree to which technical staff would buy into the process. One reason given was that TA cannot totally guarantee community acceptance of technologies and that this remaining uncertainty would decrease the value that technologists would ascribe to the process.

> *I don't know what value technologists would place on having that conversation with social scientists about perceived risks ... I think there's a huge cultural shift needs to happen for a technologist to acknowledge the value in*

> *having that conversation. And I think one of the reasons why that cultural shift is going to be difficult is precisely because you're never going to reduce uncertainty to zero (SLD10).*

4.3. WHAT FACTORS INFLUENCE HOW THE PROCESS CAN BE SITUATED WITHIN CSIRO MDU?

4.3.1. Institutional Drives

The institutional drivers shaping the Minerals Down Under Flagship align with the ideal outcomes of a technology assessment process – the development of minerals technologies that contribute to environmental and social sustainability. This has been a major driver for the Mineral Futures Collaboration Cluster within MDU which explicitly considers the social aspects of sustainability.

> *So technologies that allow us to find smaller high-grade deposits with less social and environmental impacts related to their exploitation... (SLD02).*

One interviewee went further, explaining that the success of a technology should be defined by the needs of the stakeholders and that within MDU there is scope to consider stakeholder needs more broadly indicating that social and environmental factors of concern to the broader public will increasingly define the success of technologies.

> *By definition a successful technology is one that meets the needs of its, of its users but I think more broadly it satisfies the needs of its stakeholders and in lots of ways a, our definition of success through this work hopefully will broaden to incorporate a different, a broader set of stakeholders in that technology... (SLD01).*

In general it was believed that the institutional context within CSIRO was changing and becoming more aligned to considering the social impact of technologies being developed.

> *Now there is a much greater emphasis on ... the application and impact [of technology]. Whilst in many ways that's still rhetoric, the organisation has moved a long way (SLD01).*

> *In the flagship broadly…we certainly wouldn't be doing anything that we didn't think had a long-term future from a sustainability and social perspective (SLD02).*

4.3.2. Constraints of Interdisciplinary Work

There was some concern from both groups about working in interdisciplinary teams. This is partly due to the history of social science work in CSIRO despite both groups giving examples of positive and beneficial collaborations.

> *Generally there's (sic) social science has been mis-valued in science generally as well as in CSIRO but increasingly projects are discovering that they need to have an*

> *integrated approach... So there's some complaint within the social sciences that we need to be more integrated into the overall project design and not just an add-on (SLD07).*

For technologists the most commonly stated constraining factor for interdisciplinary work focused on communication difficulties between disciplines. Social scientists were said to use language that was difficult for the technical scientists to understand. There was also concern that social scientists may not be able to contribute to the process effectively without considerable domain knowledge.

> *Sometimes the social scientists come up with words that I just don't understand, but mostly, it's easy to work with this kind of research because it is so close to home (SLD04).*

> *But [communicating across disciplines is] not easy to do, either for the scientists undertaking stuff to kind of understand the language and the perspective that social scientists may bring, but also for social scientists to understand if they're not technically literate, if you like, to understand the impact of the specific technical decisions that might be being discussed or taken (SLD05).*

> *Oh, look, I think it would work well, as long as the language is okay, we can understand each other. You need some sort of degree of technical literacy, I suppose, and [to] understand the jargon. We'd probably need to understand their jargon as well… (SLD06).*

Despite the language issues there was still considerable value placed on the role that social science could play.

> *I mean in some projects, no, but in a lot of projects, like a new type of mining or something which is (sic) clearly – has high profile, then social scientists are almost essential (SLD04).*

Social scientists expressed ideological concerns especially about the potential for social science work to become an add-on rather than social scientists being involved in shaping research outcomes from the outset. One interviewee noted that a personal conflict could arise if the process of technology assessment was viewed only as a tool for convincing the public to accept a technology rather than for actually considering and implementing community concerns in the design of technologies.

> *Which can be a problematic position to be in, I think, as a researcher ... If you're a sort of a tool for achieving legitimacy but you're not actually having any influence on technology choices (SLD05).*

> *But the thing is if [social scientists] are not an integral part of the research team then it tends to be not that effective (SLD02).*

4.3.3. Institutional Constraints

Both groups expressed some concern about how the process of technology assessment would be triggered within CSIRO especially whether the process would become just another layer of red tape or whether it would produce significant outcomes.

> *If you're trying to get your project operational – the idea of alerting something which makes you then go and do more procedures, more admin, more red tape, might not be appealing. So people might actually say, "Gee, I'd rather not deal with this social risk, I've got enough dealing with the OHS, and the environmental, and everything else, I'll fudge that," you know (SLD08)?*

The ability of the process to shape the outcomes of technologies is also dependent on the other drivers shaping technological development and how institutional factors prioritise these drivers.

> *But in general [we] look at what kinds of design objectives can be accommodated together. And what (sic) end up being trade offs for each other in that if you design for recyclability or you design for other things, safety, waive cost, da, da, da, often they involved tradeoffs (SLD05).*

4.3.4. Limited Case Studies

One of the factors that could limit acceptance of the technology assessment process was that currently no case studies exist to demonstrate the value of the process.

> *But because we haven't had the experience, I can't really tell you whether it's possible or not … to redesign things. Now, ideally this should happen and evolve [from] the very early stage, but in most cases for one reason and another, that doesn't happen. So, the social side could become an add-on, in which case then you have to accommodate that output (SLD09).*

4.4. WHAT FACTORS INFLUENCE THE REFLEXIVITY OF TECHNOLOGY DEVELOPMENT?

The characteristics of a technology, such as the stage of development, technical flexibility, and level of complexity, affect the ability to modify the technology in response to social vetting outcomes.

> *...it's [understanding and integrating community concerns] much easier to do I guess in more smaller (sic) scale infrastructure like that (SLD07).*

Characteristics of the technologist's themselves also shape the capacity of a technology to be designed (or re-designed) to accommodate broader stakeholder concerns. The ability of the technologist to empathise with stakeholder's concerns is one such factor.

> *And it comes back to this issue – what an engineer or scientist thinks…doesn't necessarily resonate with [the] general population at all (SLD02).*

> *They've [technologists] got to be aware of the risks of technology. And then they've got to be able to put themselves in a position of people who would be affected by that technology (SLD03).*

> *But I think there is quite a significant disconnect between what technical people would think is a solution and what (sic) the public perception of the technology, you know, how they relate to one another (SLD02).*

The primary objectives and constituents of CSIRO's Minerals Down Under programme also affect the technologist's ability and willingness to adapt technologies in accordance with factors that are beyond the narrowly defined parameters of commercial interests.

> *Now often our technologies are not completely discrete. They relate to historical technologies and existing operations and so on. So there is a sensitivity there about what CSIRO's role is, what's appropriate for CSIRO to comment on and what can we influence and so on (SLD02).*

> *So why don't we just do our best job at building the technology to be as functional as possible, and then it's for someone else to worry about whether or not this is suitable to go into a plant or suitable for implementation in a community. That's what the regulator does. It's not our job (SLD10).*

Time and cost restraints we're also factors mentioned that could prevent the functionality of a technology assessment process.

> *I think people need it to be easy for them and I'm not sure how much appetite there is for putting resources into it from a technical budget. ... But if we can come up with a methodology and a support system that encourages people to think about social issues in the early stages of ... technologies, then I think there's every chance it can get embedded in Minerals Down Under, and I think ... if we don't do it, ... we'll miss an opportunity, I think, to lead the way in terms of ... factoring social licence into the design phase (SLD10).*

5. DISCUSSION

Whilst support from technical staff exists in rhetoric there was a disparity between how social science staff viewed the benefit of technology assessment and how technical staff did. Commonly technical staff mistook the inclusion of social scientists in technological development as an avenue for communicating risk to community members and therefore enhancing the success of the technology they were developing. Social scientists were more concerned with TA as a way of challenging normative assumptions held by technologists and were concerned, based on past experience, that they would be undervalued, coming into projects as an add-on or because they could not guarantee a certain outcome from the process.

Both characteristics of the technology and the technologist themselves affect the ability of technologies to be altered to accommodate social considerations. If a CTA is not carefully designed there is the potential for institutional constraints to be a factor that limits the consideration of social issues in technology design in CSIRO, as previously identified by Katz et al. (2009). In light of this the following features have been incorporated into the Social License in Design process.

5.1. CTA AS A PROCESS RATHER THAN A ONE-OFF ASSESSMENT

Social License in Design should be approached as an ongoing iterative process of inquiry and reflection, utilizing a multitude of methods tailored to the individual circumstances of the technology under consideration (some of the issues to be considered in such a process are outlined in **Figure 3**). Methods may include social risk assessment workshops, focus groups, scenario planning, citizen juries, social profiling and interviews. In this way the focus is not to provide recommendations to be adopted, but to expose technologists to the context in which the technology may be situated and encourage reflection and incorporation of such values, perceptions and realities (reflexive technology). Clearly some technologies, such as minor modifications to equipment already in widespread use present significantly less potential for unanticipated positive or adverse impacts and as such should attract less scrutiny and attention than more novel technologies. This has the effect of reducing the potential for onerous assessments where the benefits are not easily apparent. The caveat to this is that care must be taken to retain opportunities to uncover and imagine unanticipated issues. This requires critical reflection.

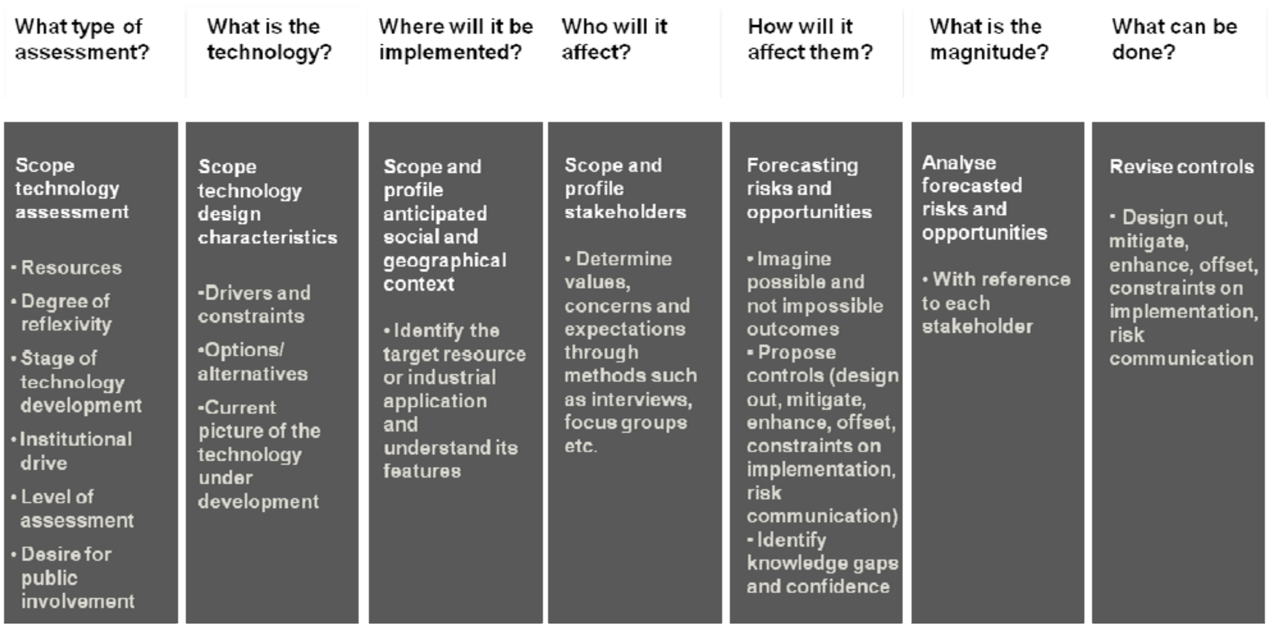

Figure 3: Potential issues to be considered during an iterative Social License in Design CTA process.

5.2. RESPONSIBILITY FOR OUTCOMES NOT OUTPUTS

The relationships between technical and social science staff are critical to the success of CTA. The decision point for initiating CTA is most obvious during budgetary and planning cycles (Figure 5). To avoid the potential for ineffective assessments and to identify the most worthy technologies one possible trigger is for technology managers to have a responsibility to be satisfied that the social implications are understood and have been adequately addressed. Should this not be the case a dialogue with technically literate social science staff (who would be responsible for the technology assessment process) can begin and research components and deliverables can be developed given the available resources. This provides an opportunity to negotiate mutually beneficial outcomes for social and technical scientists whereby technologists are exposed to a reflexive process of inquiry to improve technologies and social scientists are not limited to a role to win public support for technologies.

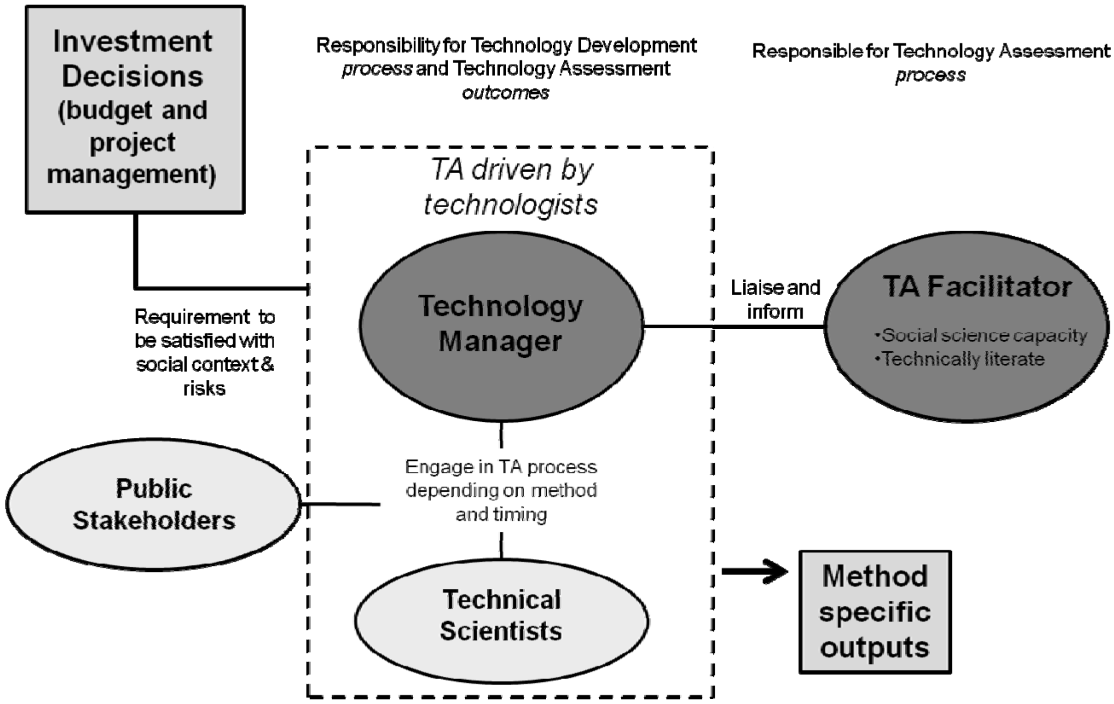

Figure 4: Roles and responsibilities for a Social License in Design CTA process.

5.3. ESCALATING FORMALITY AND ENGAGEMENT AS PART OF A 'VETTING' SPECTRUM

There are legitimate issues that exist with regard to the appropriate timing for engagement with external stakeholders. During the conceptual and experimental stages of technology development stakeholder values and views might be best expressed through representatives that fulfill the function of 'critical friends' to challenge assumptions. As technologies become more tangible it is then increasingly more appropriate to seek the views of 'critical outsiders'. At this stage actual stakeholders may be more easily identified as trials or pilot projects proceed.

It should be noted that CTA is not a substitute for public policy focused technology assessment agencies (such as the Scientific and Technological Options Assessment (STOA) office of the European Parliament), or impact assessment processes that are usually a requirement of project approvals. It is unreasonable to expect that professionals undertaking and assisting technology assessment within institutions will have the same scope or remit to critically appraise technology as public policy focused technology agencies. The institutions and professionals developing technology quite naturally have a stake in the success of the innovation. Instead, the purpose of CTA within institutions should be to enable the technologist to experience a learning process about the technology under study and reflexively apply this learning to the design of the technology. The benefit of early reflection is that the possibilities for responding to any issues are greatly enhanced (**Figure 5**).

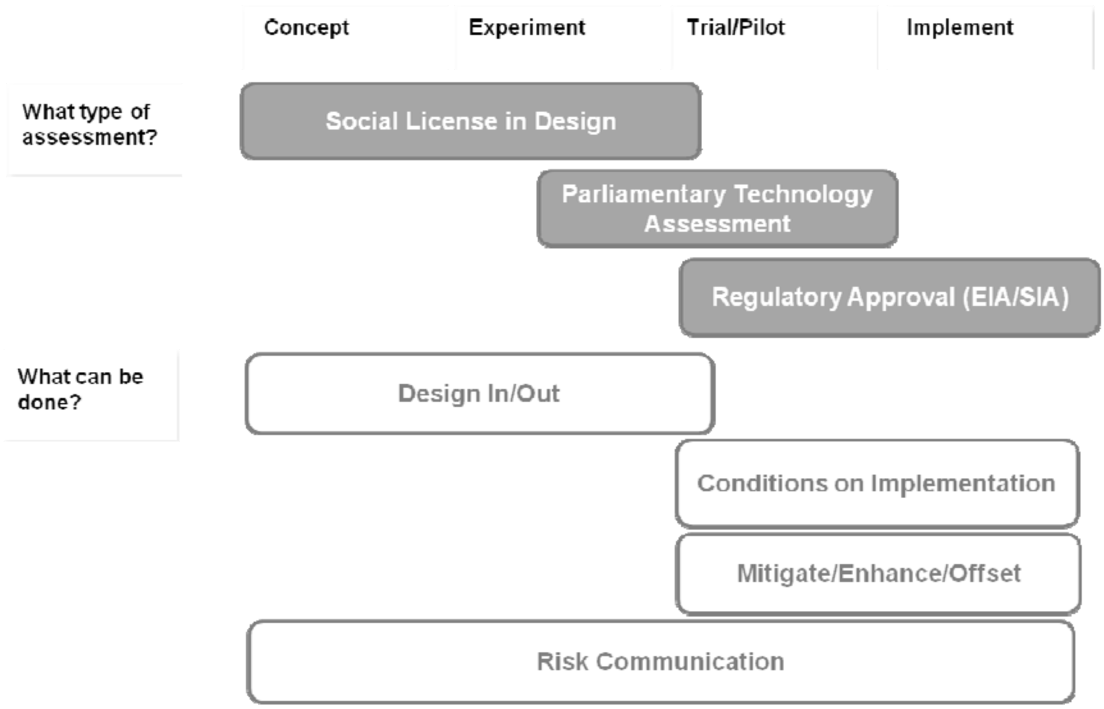

Figure 5: The relationship between technology assessment (Social License in Design, parliamentary technology assessment and impact assessments) and available controls.

6. CONCLUSION

Social License to Operate is influenced by a multitude of factors, only some of which are related to technological traits. Communities are dynamic and inherently unpredictable, the manifestation of issues, risks, and opportunities are complex, and finally foresight is imperfect. These limitations are significant challenges to CTA. While not all potential social risks can be designed out, and not all opportunities enhanced, for issues that are intrinsic to particular technologies and the way in which they interact to different social and environmental contexts there is much to benefit from early consideration and resolution.

The minerals industry is increasingly focused on the social performance of their operations and there is a complementary role that R&D institutions can play to respond through the design socially reflexive technologies. Demonstration of the value of CTA is critical for successful uptake. Case studies of Social License in Design are proceeding to refine the process, build support and examine the value and efficacy of the necessary investment of time and resources.

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